FRESHWATER CLADOCERA (CRUSTACEA) OF SOUTHERN TAMIL NADU[1]

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(*With four text-figures*)

Key words: Cladocera, 46 species, Tamil Nadu, freshwater, wetlands.

The investigation on the taxonomy of Cladocera shows that about 46 species belonging to five families Sididae, Daphniidae, Moinidae, Macrothricidae and Chydoridae are represented in and around southern Tamil Nadu, of which 34 are new records. The species composition of Cladocera in the present study has some features unique to this region. Leptodoridae, Halopedidae and Polyphemidae are absent and species belonging to the genera *Pleuroxus* as well as *Ceriodaphnia* are scarce. Only four species of Cladocera are distinctly dominant in the limnetic zooplankton of southern Tamil Nadu. They are *Daphnia similis, Ceriodaphnia cornuta, Moina micrura* and *Diaphanosoma excisum*. Littoral regions of the wetlands of southern Tamil Nadu are dominated by *Pseudosida bidentata* and *Latonopsis australis,* two co-occurring members of the family Sididae. The tropicopolitan and cosmopolitan forms of Cladocera predominate the southern Tamil Nadu wetlands. Two unexpected species *Daphnia longicephala* and *Daphnia projecta* are recorded for the first time in India. Two rare species, namely *Alona* cf. *karelica* and *Graptoleberis testudinaria* were also found in the present study.

INTRODUCTION

Though the Cladocera of the Indian region have been studied by different authors, those of South India, especially Tamil Nadu, have received scant attention. Michael (1973) and Murugan and Job (1981) have briefly dealt with a few species occurring in and around Madurai, Tamil Nadu.

The present work on the taxonomy of Cladocera of southern Tamil Nadu was conducted in Madurai, Ramnad, Tirunelveli and Kanyakumari districts. Extensive and intensive sampling was undertaken in 1979 and all the available species were studied in detail. Over 700 samples were collected from various types of habitats and a total of 46 species of Cladocera were identified, of which 34 were recorded for the first time from this region.

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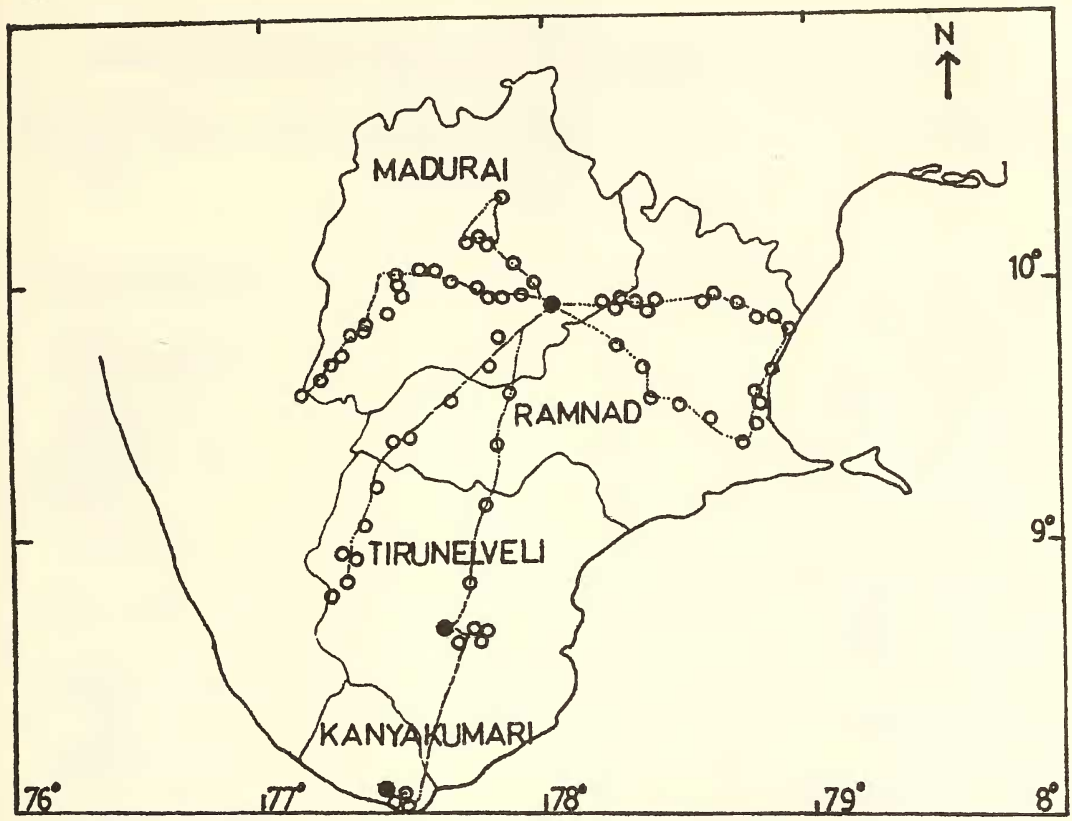
MATERIAL AND METHODS

The sampling sites are shown in Fig. 1. Plankton nets with 36 cm diameter were used. The net was dragged among the vegetation close to the bottom of the shallow waters in marshes. Oblique hauls were taken to obtain zooplankton from the shores of the man-made reservoirs and ponds.

The concentrated samples were preserved in 5% and 10% formalin with one teaspoon per litre sugar and 95% glycerine alcohol and were stored in 50 or 100 ml plastic containers for taxonomic studies. The technique of Fernando (1980a) was adopted to prepare the head-shields of species of Chydoridae. The specimen was placed on a cavity slide containing concentrated HCl, heated and later cooled. The head shield was carefully dissected out and permanently mounted using Lactophenol and Canada balsam. Mounts of the entire specimen were also made for Macrothricidae, Moinidae and Chydoridae.



○ Collection spots ● Major towns

Fig. 1: Area where Cladocera samples were collected for study in southern Tamil Nadu

Results

Detailed study of the collections revealed the occurrence of 46 species of Cladocera belonging to 23 genera and 5 families (Table 1). A systematic account of a few of the rare species recorded in the present study are given below.

Family Daphniidae

1. ***Daphnia longicephala***

Hebert 1977 (Fig. 2)

Female: Body size 4.2 mm. Anterodorsal cephalic crest present; shape and length of the crest vary; dorsal margin with well developed spines; rostrum acute, extends up to ventral carapace margin. Eye situated well away from the margin; ocellus often absent, if present very minute. Postabdomen with 8-12 anal spines; claw with 9-10 proximal, 14-16 middle and 28-36 distal pectens.

Distribution: Southern Tamil Nadu: Madurai and Ramnad dist. Elsewhere: Single report from New South Wales (Hebert 1977). This is the first record of its occurrence in India.

Remarks: Well developed anterodorsal helmet and conspicuous spines on the dorsal margin are distinguishing characters which separate this species from *D. cephalata* King. However, Grant and Bayly (1981) reported that the present species is only a polymorphic species

TABLE 1
SPECIES OF CLADOCERA RECORDED FROM SOUTHERN TAMIL NADU AND OTHER REGIONS OF INDIA AND SOUTHEAST ASIA

Sl. No.	Name of species	Previous records from Tamil Nadu including Northern Districts	North-eastern India (West Bengal and and Tripura)	Andaman and Nicobar Island	Sri Lanka	Malaysia	Distribution (Present study)
	Family SIDIDAE Sars						
	Genus *Latonopsis* Sars						
1.	*L. australis* Sars	—	4,5	6	7	8	common
	Genus *Pseudosida* Herrick						
2.	*P. bidentata* Herrick, 1884	—	4,5	6	7	8	common
	Genus *Diaphanosoma* Fischer						
3.	*D. excisum* Sars	1,3	4,5	6	7	8	very common
4.	*D. sarsi* Richard	3	4,5	6	7	8	very common
5.	*D. senegalensis* (Gauthier)	—	—	—	—	—	common
	Family DAPHNIIDAE Stratus						
	Genus *Daphnia* Muller						
	Subgenus *Ctenodaphnia* Dybowski & Grochoski						
6.	*D. similis* Claus	—	4	—	7	8	common
7.	*D. cephalata* King	1	—	—	7	—	common
8.	*D. longicephala* Hebert	—	—	—	—	—	rare
9.	*D. projecta* Hebert	—	—	—	—	—	very rare
10.	*D. lumholtzi* Sars	1,2,3	4,5	—	7	—	common
	Genus *Simocephalus* Schdler						
11.	*S. acutirostratus* (King)	1, 2	5	—	7	—	common
12.	*S. vetulus elizabethae* (King)	—	4,5	—	7	—	common
13.	*S. serrulatus* (Koch)	—	5	—	—	8	very rare
14.	*S. latirostris* Stingelin	—	5	—	—	8	rare
15.	*S. exspinosus* (Koch)	—	—	—	7	—	rare
	Genus *Scapholeberis* Schdler						
16.	*S. kingi* Sars	1,2	4,5	6	7	8	common
	Genus *Ceriodaphnia* Dana						
17.	*C. cornuta* Sars	1,2,3	4,5	6	7	8	common
	Family MOINIDAE Goulden						
	Genus *Moina* Baird						
18.	*M. micrura* Kurz	1,2,3	4,5	6	7	8	common
19.	*M. weismanni* Ishikawa	—	4	—	—	—	rare
	Family MACROTHRICIDAE Norman Brady						
	Genus *Ilyocryptus* Sars						
20.	*I. spinifer* Herrick	—	4,5	6	7	8	common
	Genus *Macrothrix* Baird						
21.	*M. laticornis* (Jurine 1820)	3	—	6	—	—	rare
22.	*M. spinosa* King	1,3	4,5	6	7	8	common
23.	*M. triserialis* Brady	—	4,5	6	7	8	common

TABLE 1 (*contd.*)
SPECIES OF CLADOCERA RECORDED FROM SOUTHERN TAMIL NADU AND OTHER REGIONS OF INDIA AND SOUTHEAST ASIA

Sl. No.	Name of species	Previous records from Tamil Nadu including Northern Districts	North-eastern India (West Bengal and and Tripura)	Andaman and Nicobar Island	Sri Lanka	Malaysia	Distribution (Present study)
	Family CHYDORIDAE Stebbing						
	Subfamily Chydorinae Frey						
	Genus *Pleuroxus* Baird						
24.	*P. aduncus* (Jurine)	—	—	—	—	—	rare
	Genus *Dadaya* Sars						
25.	*D. macrops* (Daday)	—	5	6	7	8	common
	Genus *Chydorus* Leach						
26.	*C. parvus* Daday	—	—	6	7	8	common
27.	*C. ventricosus*	—	4, 5	6	7	8	common
28.	*C. eurynotus* Sars	—	—	6	7	8	common
	Genus *Ephemeroporus* Frey						
29.	*E. barroisi* Richard	—	4,5	6	7	8	common
	Genus *Dunhevedia* King						
30.	*D. crassa King*	—	4,5	6	7	8	common
31.	*D. serrata* Daday	—	4,5	6	7	8	common
	Genus *Pseudochydorus* Fryer						
32.	*P. globosus* (Baird)	—	4,5	—	7	—	rare
	Subfamily Aloninae Frey						
	Genus *Alona* Baird						
33.	*A. monocantha tridentata* (Stingellin)	—	4,5	6	7	8	common
34.	*A. davidi* Richard	—	4,5	6	7	8	common
35.	*A.* cf. *karelica* Stenroos	—	—	—	—	8	very rare
36.	*A. pulchella* King	—	4,5	6	7	8	common
37.	*A. sarasinorum* Stingelin	—	—	—	—	8	very rare
	Genus Graptoleberis Sars						
38.	*G. testudinaria* (Fischer)	—	4	—	7	8	very rare
	Genus *Kurzia* Dybowski & Grochowski						
39.	*K. longirostris* (Daday)	2	4	6	7	8	common
	Genus *Leydigia* Kurz						
40.	*L. ciliata* (Gauthier)	—	—	—	—	—	rare
41.	*L. australis* Sars	—	—	6	7	—	common
42.	*L. acanthocercoides* (Fischer)	1,2	4,5	6	7	8	common
	Genus *Biapertura* Smirnov						
43.	*B. karua* (King)	—	4,5	6	7	8	common
44.	*B. verrucosa* Sars	—	4,5	6	7	8	common
	Genus *Oxyurella* Dybowski & Grochowski						
45.	*O. sinhalensis* (Daday)	—	4,5	6	7	8	common
	Genus *Euryalona* Sars						
46.	*E. orientalis* (Daday)	—	4,5	6	7	8	common

(1 — Michael 1973; 2 — Murugan and Job 1981; 3 — Raghunathan 1983; 4 — Venkataraman 1993; 5 — Venkataraman 1995; 6 — Venkataraman 1992; 7 — Rajapaksa and Fernando 1982; 8 — Idris 1983).

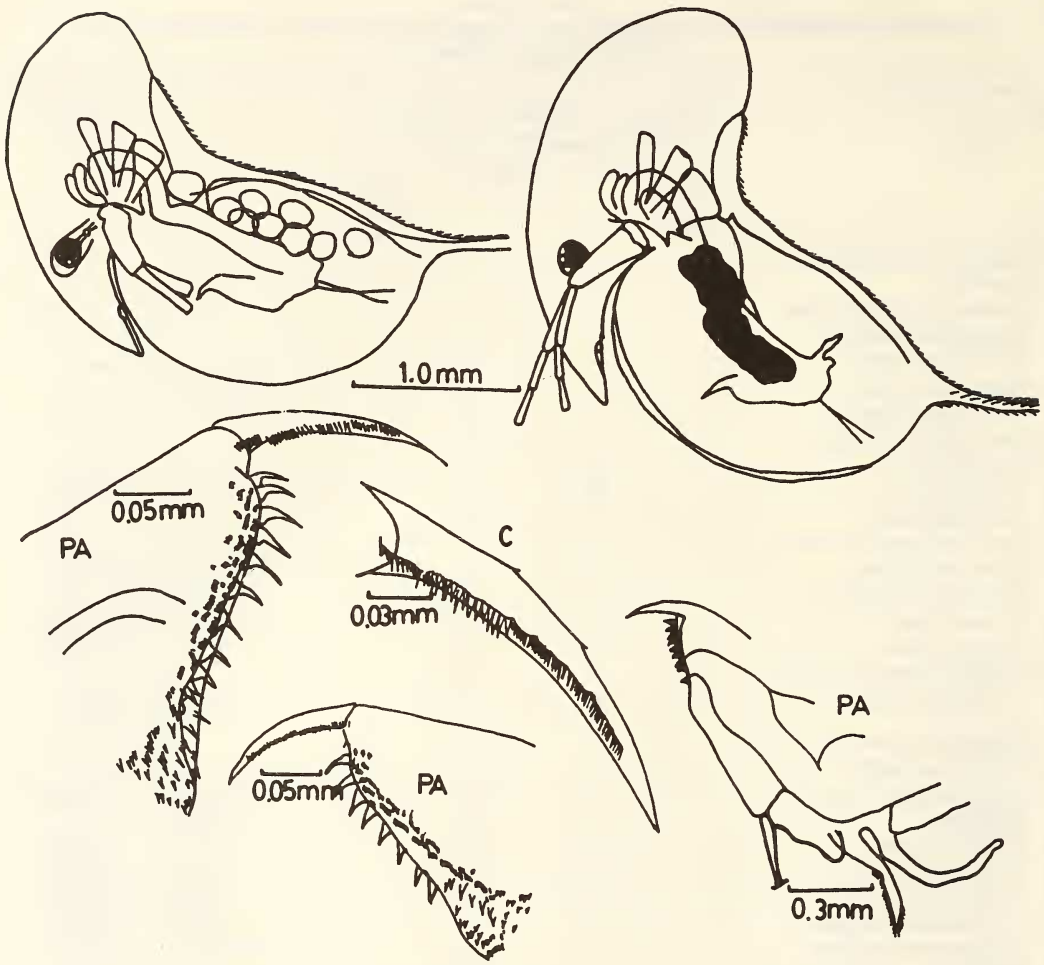


Fig. 2: *Daphnia longicephala*, Female: PA - postabadomen; C - claw.

of *D. carinata* King. Michael (1973) and Santharam (1978) described a daphnid as *D. cephalata* resembling *D. longicephala* Hebert from a pond near Madurai. The specimens examined in this study agree with Michael's and Santharam's descriptions.

2. ***Daphnia projecta*** Hebert 1977 (Fig. 3)

Female: Body size 2.2 mm. Dorsoanterior helmet; eye small; ocellus inconspicuous. Rostrum slightly recurved and pointed. Strong carapace spines; tail long, equal to the length of carapace. Postabdomen with 8-12 anal spines. Reproductive females less than 1.5 mm.

Male: Body size 1 mm. Head large with anterior helmet; rostrum absent, dorsal margin of head and body straight with spines. Antennules movable; flagellum not well developed. Eye large and ocellus inconspicuous. First pair of legs modified to form prehensile organ with a long seta. Postabdomen with 10-12 anal spines.

Distribution: Southern Tamil Nadu: Madurai, Ramnad and Tirunelveli dist. Elsewhere: Australia.

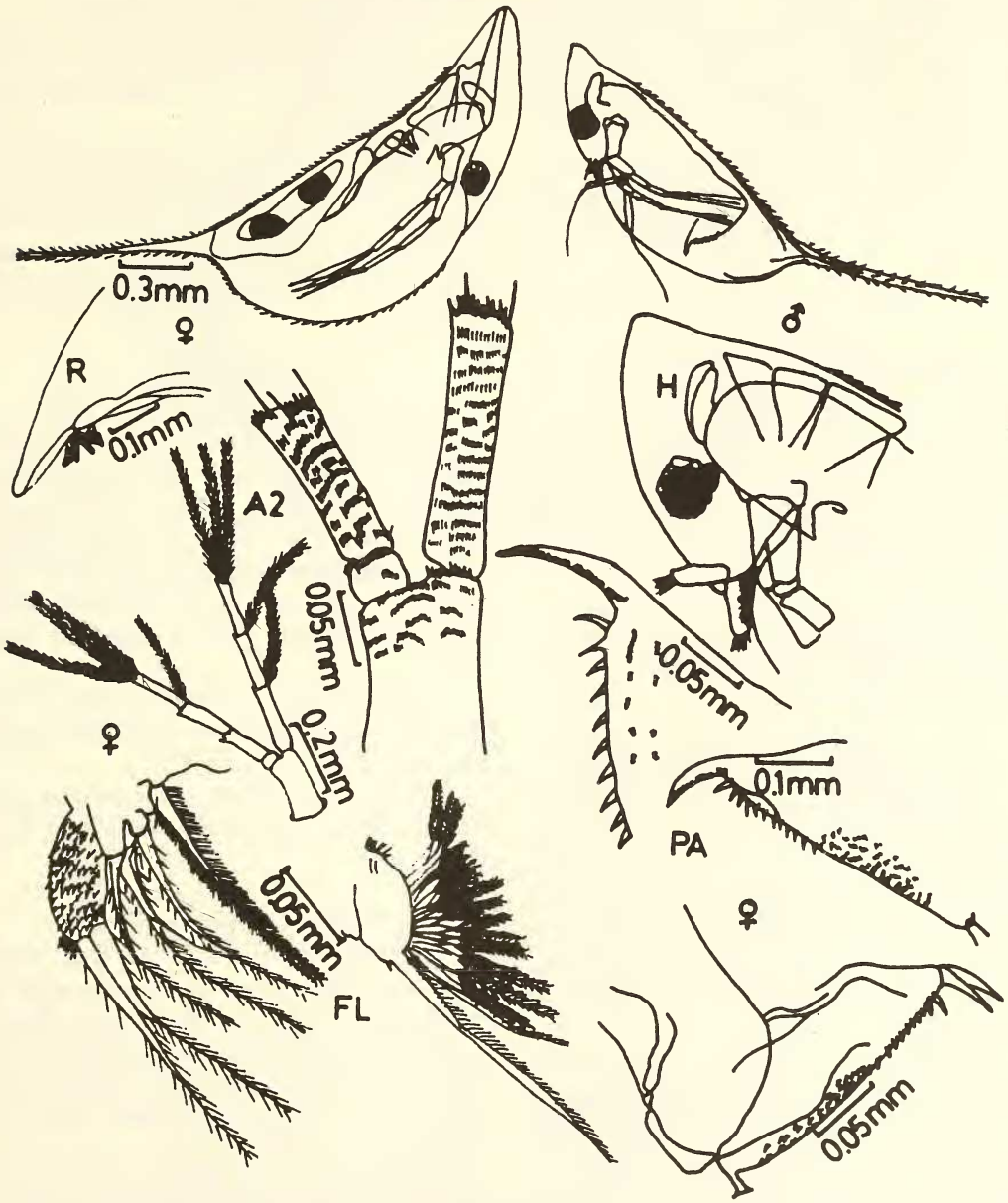


Fig. 3: *Daphnia projecta*, Female: R - rostrum; A2 - antenna; FL - first leg; PA - postabdomen. Male: H - head.

Remarks: This is the first report of the occurrence of this species outside Australia. It was considered endemic to Australia (Hebert 1977). The present study extends its distribution to this region. Hebert (1977) recorded this species as one of the commonest planktonic forms in the temperate region (Australia). So far, it has not been recorded from tropical Asia, southeast Asia, Africa and America. The present description of this species extends its distribution to southern Tamil Nadu.

3. ***Simocephalus sérrulatus*** (Koch 1841)

Female: Body size 1.35 mm. Body oval; posterior region wide. Dorsal margin evenly arched and ventral margin bulging in middle. Head small; eye large. Anteriormost region of head with a number of minute denticles. Ocellus rhomboidal in shape. Postabdomen with 6-8 anal denticles. Claw without pecten and setules on concave margin.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Australia, Africa, China, Europe and Southeast Asia.

Family Moinidae

4. ***Moina weismanni*** Ishikawa 1896

Female: Body size 0.9-1.0 mm. Hairs present on head and body. Antennules ornamented with spines with a sensory seta at the middle. Postabdomen with 7-9 feathered setae. Ephippia with raised knobs at the centre.

Male: Body size 0.77 mm. Four hooks on the antennule of male. Hook on the first leg not well developed.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Cambodia, China and Japan.

Remarks: Under the genus *Moina,* so far only two species, namely *M. micrura* and *M. macrocopa*, have been reported from India. *M. weismanni* is a new record for India.

Family: Macrothricidae

5. ***Macrothrix laticornis*** (Jurine 1820)

Female: Body size 0.43-0.55 mm. Head rounded; rostrum small with two antennules. Ventral margin of carapace with movable spines. Postabdomen with numerous fine spines.

Distribution: Southern Tamil Nadu: Madurai and Ramnad dist. Elsewhere: Nepal, China, Bangladesh, Africa, North and South America and Europe.

Remarks: Dumont and Van der Velde (1977) compared the materials from Belgium (*M. laticornis*), Australia (*M. spinosa*) and Israel (*M. goeldii*) and pointed out that *M. laticornis* may occur in tropical regions as well as coexist with *M. spinosa.*

Family Chydoridae

6. ***Pleuroxus aduncus*** (Jurine 1820)

Female: Body size 0.47 mm. Head small. Antennules with pegs near the base, reaching the middle of rostrum. Labrum with pointed apex. Posteroventral corner with varying number of spines. Valves with lines on the anteroventral region. Postabdomen with 10 denticles decrease in length proximally. Claw with two basal spines.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: India - Rajasthan; Nepal, Africa and South America.

Remarks: *P. aduncus* is a cosmopolitan species. Smirnov (1974) described four subspecies.

7. ***Chydorus parvus*** Daday 1898

Female: Body size 0.35 mm. Head small; antennules not reaching the apex of rostrum. Ocellus situated nearer to eye than to the apex. Posteroventral corner without denticles. Anterior margin of valves with tubercles on the inner side. Postabdomen with 9-10 denticles.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere - Nepal, Sri Lanka, Malaysia and Africa.

Remarks: This species can be recognised by the presence of tubercles on the surface of anterior margin of valves.

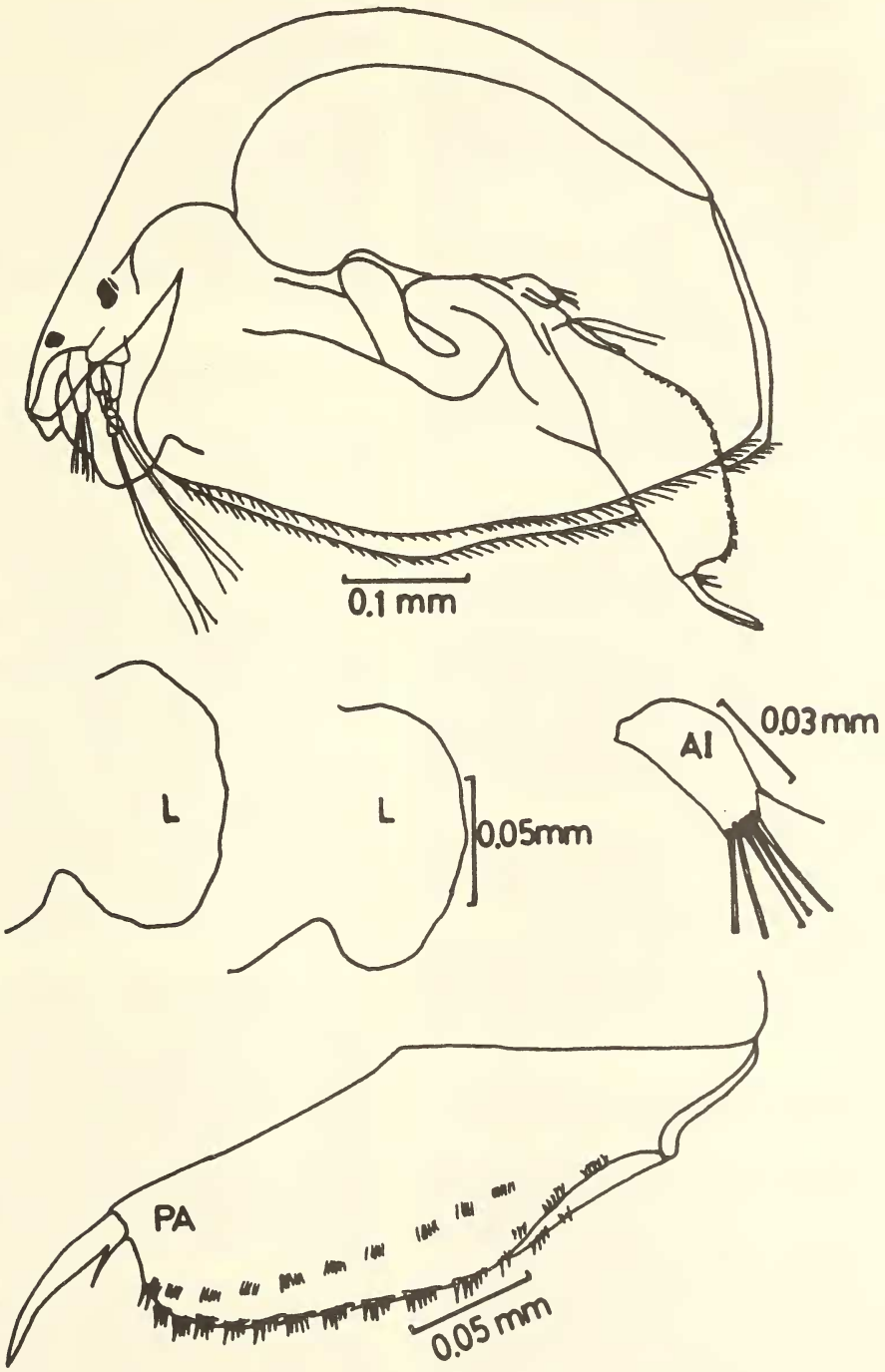


Fig. 4: *Alona sarasinorum*, Female: L - labrum; AI - antennule; PA - postabdomen

8. ***Pseudochydorus globosus*** (Baird 1843)

Female: Body size 0.4-0.7 mm. Head small with pointed rostrum. Anteroventral margin of valve with concentric stripes and hexagonal cells. Postabdomen with 15 anal denticles. Claw with two basal spines.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: India - Rajasthan; Sri Lanka, Malaysia, Australia, Africa and China.

Remarks: The genus *Pseudochydorus* was established by Fryer (1968) on the basis of significant differences noticed in the trunk limbs of other species of *Chydorus*. This is the first record of *P. globosus* in Tamil Nadu.

9. ***Alona* cf *karelica*** Stenroos 1897

Female: Body size 0.4 mm. Head small, rostrum blunt. Ocellus slightly smaller than eye, situated halfway between eye and apex of rostrum. Labrum rounded with a slightly pointed apex. Postabdomen with distal dorsal end projecting beyond the base of claw; anal margin concave; preanal corner projecting, 8-10 anal denticles with small setae on the inner margin; claw with a basal spine.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Malaysia, Germany and Northwest Europe (erstwhile USSR).

Remarks: This species was originally described from temperate regions. Idris and Fernando (1981) reported this species from Malaysia.

10. ***Alona sarasinorum*** Stingelin 1900 (Fig. 4)

Female: Body size 0.52 mm. Head small; rostrum blunt. Antennules almost reaching the apex of rostrum. Ocellus slightly smaller than eye. Labrum rounded anteriorly and acutely rounded posteroventrally. Ventral margin of valves with a series of setae, with setules between the setae. Postabdomen with 12 groups of denticles. Claw with a basal spine.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Malaysia, Indonesia.

Remarks: Only a few specimens were found in a pond, in the Madurai Kamaraj University Campus, Madurai. A collection from Murugan temple pond at Port Blair containing *A. sarasinorum* in good quantity resembles the present description. Insufficient information in previous descriptions makes it difficult to identify this species.

11. ***Graptoleberis testudinaria*** (Fischer 1848)

Female: Body size 0.6 mm. Head large with the tip of rostrum semicircular. Antennules not reaching the apex of rostrum. Labrum rounded. Ocellus smaller than eye. Posteroventral corner of valves with three denticles. Postabdomen with 6-8 lateral groups of setae present; claw without basal spine.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Sri Lanka, Malaysia, Nepal, Australia and South America.

Remarks: The number of denticles present in the posteroventral corner of the valve may differ in number on the left or right valve or be absent (Smirnov 1974). Sklyarova (1947) reported five denticles, Gauthier (1928) four and in the present study three were found. Smirnov (1974) has described five subspecies.

12. ***Leydigia ciliata*** (Gauthier 1939)

Female: Body size 1.00 mm. Head small. Ocellus triangular in shape; equal in size with eye. Antennules not reaching the apex of rostrum. Labrum undulate, with hairs on anterior margin. Periphery of valves with rows of granules. Postabdomen wide, with groups of lateral setae; anal denticles small; anal margin slightly convex with setae; claws with a small basal spine and setae.

Male: Body size 0.65 mm. Antennule with spear-like setae on the distal margin. Vas deferens open at apex of a penis-like process on the dorsal side of postabdomen. First leg with a hook.

Distribution: Southern Tamil Nadu: Madurai, Ramnad, Tirunelveli and Kanyakumari dist. Elsewhere: Nepal, China, Africa, Australia and South America.

Remarks: The present material collected at Madurai, Ramnad, Tirunelveli and Kanyakumari dist. agrees with Harding's (1955) description in the size of the ocellus which is slightly bigger than the eye, in the antennules not reaching the tip of the rostrum, and in the presence of a claw with a basal spine.

Discussion

The Cladoceran fauna of southern Tamil Nadu exhibit certain features unique to the region. A total of 46 species belonging to 5 families have been recorded in the present study, out of which 34 are new records.

The species spectrum of limnetic Cladocera is far more limited in the tropics than in temperate regions (Fernando 1980a). However, in southern Tamil Nadu, which is located in tropical India, as many as five species of *Daphnia*, namely, *D. similis*, *D. cephalata*, *D. longicephala*, *D. projecta* (records in present investigation) and *D. lumholtzi* (Michael 1973; Murugan and Job 1981), all of them probably temperate in origin, were found to occur. This is rather unusual, as the genus *Daphnia* is normally the most evident absentee from tropical freshwaters (Fernando 1980b). However, there are previous records of *D. lumholtzi* by Poppe and Mrajek (1895) (misidentified as *D. galeate,* Fernando 1980b) and three species of *Daphnia* in Sarawak (Spandal, 1924) and the relatively large number of *D. similis* recorded in Thailand, which Fernando (1980b) considers as probable introductions. Several explanations are given on the mode of such introductions. Birds have been considered an important agency for the dissemination of microcrustaceans in freshwaters (Thienemann 1950; Loffler 1963; Smirnov 1974). In fact, rice fields attract aquatic bird migrants. Import of food grains is another important means of transporting alien Cladocera into the country (Mukhamediev 1951; Mizuno and Mori 1970).

The species composition of limnetic Cladocera of southern Tamil Nadu is typical of tropical regions. The marked differences in the number of limnetic species in tropical and temperate regions is conspicuous, as pointed out by Fernando (1980a, b). Only four species of Cladocera, which are eurytopic, occurring in a wide range of habitats, were found to be distinctly dominant in the limnetic zooplankton of southern Tamil Nadu, as is the case with the entire southeast Asian regions (Fernando 1980b). They are *Daphnia similis, Ceriodaphnia cornuta, Moina micrura* and *Diaphanosoma excisum* (Table 1).

It is interesting to note that large Cladocera found in the littoral zone of temperate regions, namely *Eurycercus* and *Saycia,* the largest Chydoridae, are completely absent from the tropical region (Frey 1971). In the present study, two co-occurring members of the family Sididae, *Pseudosida bidentata* and *Latonopsis australis* were found to dominate the littoral region. Among the five species of the genus *Simocephalus, S. acutirostratus* and *S. vetulus elizabethae* occurred in most of the littoral samples. However, they are rarer here than in the temperate region where this genus is abundant. Further, *Scapholeberis kingi* and *Dadaya macrops,* the two epineustic pantropical Cladocera, as well as *Euryalona orientalis* are very common in the littoral region of southern Tamil Nadu. Two species of the family Bosminidae reported from Sri Lanka (Rajapaksa and Fernando 1982) and other Southeast Asian tropical regions were not found during the present study.

Comparison of the species diversity and size spectrum of Cladocera from tropical and temperate regions reveals a marked difference, the species size and spectrum being much smaller in the tropics than in temperate regions. In the present study, the lower end of the size range

was found to be occupied by *Dadaya macrops* (0.4 mm). Two of the largest forms, *Daphnia cephalata* and *Daphnia longicephala* reach a maximum size of 3.5 - 5.0 mm, while the same species reach 5.0 - 6.0 mm in temperate Australia (Hebert 1977).

While assessing the reasons for fewer and smaller Cladocera occurring in tropical lentic waters, the role of various factors like evolutionary history, physiology, population dynamics, temperature, availability of food and predator pressure should be carefully weighed (Fernando 1980b). Lack of large standing freshwaters (lakes) in southern Tamil Nadu, both in space and time, could account for limited Cladoceran fauna. The uniform high temperature prevailing in this region might have restricted niche diversity seasonally, thus reducing the number of species, as pointed out by Fernando (1980b).

Temperature has many direct and indirect effects on the species diversity and size range of *Daphnia.* In the present study, the small-sized *Daphnia similis* (2.2 mm) appeared to dominate the temporary ponds. However, the larger species, *D. cephalata* and *D. longicephala* also occur in limited numbers. In the tropics, the prevailing temperature lowers fecundity and feeding efficiency (Fernando 1980b), thus accounting for the absence of larger *Daphnia.* Also, it has been shown that feeding efficiency in *Daphnia* increases with size (Burns and Rigler 1967), but the optimum size decreases with the rise in temperature (Lynch 1977).

It is generally accepted that the major factor in reducing the size of zooplankton is predation by fish (Harbacek 1977). In the present study, in the river-fed man-made reservoirs with large numbers of planktivorous fish, larger daphnids like *D. cephalata* and *D. longicephala* are conspicuous by their absence, or rapid disappearance, due to this reason. This is in conformity with the observations of many earlier workers (Zaret and Kerfoot 1975; O'Brien, *et al.* 1976; Fernando 1980a, b). In the absence of vertebrate planktivores, larger invertebrate predators like *Anisops bouveri* are found to be the dominant feeders upon small to intermediate-sized cladocerans.

In the present study, the tropical (*Dadaya macrops, Dunhevedia serrata, Ceriodaphnia cornuta, Diaphanosoma excisum, Scapholeberis kingi*) and cosmopolitan (*Pleuroxus aduncus, Pseudochydorus globosus, Moina micrura, Pseudosida bidentata, Alona karna*) forms predominate. A few endemic cladocerans such as *Alona macronyx* Daday, *Indialona ganapati* Petkovski and perhaps some *Alona* spp. found in Southeast Asia were not recorded in this study (Table 1). However, the more interesting Cladocera found during the present study are those which were earlier not expected to occur in this region, rare forms which are being recorded for the first time from a tropical region. Also, *Alona* cf *karelica* Stenroos (1897) believed to occur only in Northern Europe was earlier recorded in Malaysia (Idris and Fernando 1981) and now in this study.

Many more Cladocerans may be found to be widely distributed. Daday (1898) recorded *Graptoleberis testudinaria* and described *Indialona macronyx* from Sri Lanka. The former species is a rare form in the tropics (Fernando 1980a). However, it is recorded for the first time in southern Tamil Nadu.

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